OBSERVATIONS & RECOMMENDATIONS

After reviewing data collected from **CRYSTAL LAKE, MANCHESTER** the program coordinators recommend the following actions.

We are pleased to welcome the Manchester Urban Ponds Restoration Project to the New Hampshire Volunteer Lake Assessment Program. Manchester's volunteers collected a lot of samples this summer and we applaud them for their efforts. Although it takes a few years to establish lake quality trends, we hope that this project will encourage the citizens of the city to continue their active participation in sampling and help to reverse the degraded conditions of the ponds. We encourage the Project Coordinator to establish a wet weather sampling program in the future. Samples collected during rain events allow us to determine non-point sources of pollution to the lake. Since the project's goals include restoring the quality of the urban ponds and reducing pollutant loads data collected from wet weather sampling allows biologists to better evaluate phosphorus loading to the lake.

FIGURE INTERPRETATION

- Figure 1: These graphs illustrate concentrations of chlorophyll-a in the water column, which also is a measure of algal abundance. Algae are microscopic plants that are a natural part of lake ecosystems. Algae contain chlorophyll-a, a pigment necessary for photosynthesis. A measure of chlorophyll-a can indicate the abundance of algae in a lake. The historical data (the bottom graph) show an *improving* in-lake chlorophyll-a trend, meaning concentrations are decreasing. The concentration of chlorophyll-a was slightly increased in August, when two species of blue-green algae were some of the most dominant. While algae are present in all lakes, an excess amount of any type is not welcomed. Concentrations can increase when there are external sources of phosphorus, which is the nutrient algae and plants depend upon for growth. It's important to continue the education process and keep residents aware of the sources of phosphorus and how it influences lake quality.

- Figure 2: Water clarity is measured by using a Secchi disk. Clarity, or transparency, can be influenced by such things as algae, sediments from erosion, and natural colors of the water. The graphs on this page show historical and current year data. The lower graph shows a *stable*

trend in lake transparency. The 2000 sampling season saw the return of rain and, typically, average transparency readings are expected to be slightly lower than last year's readings. Higher amounts of rainfall usually cause more eroding of sediments into lakes and streams, thus decreasing clarity. In some cases, as with Crystal Lake, the rain may have increased flushing rates. Higher clarity readings during the 2000 season at Crystal Lake were a pleasant surprise. Crystal Lake achieved its highest mean transparency since 1995.

➢ Figure 3: These figures show the amounts of phosphorus in the epilimnion (the upper layer in the lake) and the hypolimnion (the lower layer); the inset graphs show current year data. Phosphorus is the limiting nutrient for plants and algae in New Hampshire waters. Too much phosphorus in a lake can mean excess plant and algae growth, neither of which is appealing to most lake residents! These graphs show a *stable* trend for the epilimnion, but a *worsening* trend in the hypolimnion, which means levels are increasing. Mean epilimnetic phosphorus increased in the epilimnion, while the mean hypolimnetic phosphorus was affected by a high reading in August. This was likely due to sediment that was observed in the sample. One of the most important approaches to reducing phosphorus levels is educating the public. Humans introduce phosphorus to lakes by several means: fertilizing lawns, septic system failures, and detergents containing phosphates are just a few. Keeping the public aware of ways to reduce the input of phosphorus to lakes means less productivity. Please feel free to contact the VLAP coordinator for tips on educating your lake residents or for ideas on testing your watershed for phosphorus inputs.

OTHER COMMENTS

➢ The blue-green algae *Microcystis* and *Coelosphaerium* were observed in the plankton sample (Table 2). Blue-green algae can become a nuisance species when sufficient nutrients and favorable environmental conditions are present. While overall algae abundance continues to be moderate in the lake, the presence of these indicator species should serve as a reminder of the lake's delicate balance. Continued care to protect the watershed by limiting or eliminating fertilizer use on lawns, keeping the lake shoreline natural, and properly maintaining septic systems and roads will limit phosphorus and keep algae populations in balance.

➢ The StormTreat System at Crystal Lake received some repairs this past summer. Ecocycle, who now owns the marketing and distribution rights for StormTreat, determined that the wetland plant/rice stone area of the system was not properly sealed when it was installed. This resulted in the stormwater "short circuiting" the tertiary treatment capabilities of StormTreat. Despite the fact that Ecocycle did not improperly install the Crystal Lake units, they invested a considerable amount of funds and time to repair the StormTreat system.

Despite last year's efforts, there are a few other problems that need to be addressed before the StormTreat units are running at 100%. The planting of wetland plants and minor modifications to the pre-StormTreat sediment box should be completed by late spring.

- The proposal for the residential subdivision at the southwest end of Crystal Lake was rejected, due mainly to the efforts of the Crystal Lake Preservation Association and the Manchester Conservation Commission. The City is now trying to acquire the property to prevent it from being developed.

NOTES

- Monitor's Note (5/30/00): Great blue heron visits everyday. Beaver(s) at outlet. No DO/temp profile; Hydrolab battery dead.

- Monitor's Note (8/24/00): City has no lifeguard at beach, 10 swimmers present.

- Biologist's Note (8/24/00): Lots of sediment in hypolimnion sample.

- Monitor's Note (9/25/00): No chain. Since water column was isothermic, we just took a grab sample for deep spot samples and chlorophyll-a.

USEFUL READING

Soil Erosion and Sediment Control on Construction Sites, WD-WEB-12, NHDES Fact Sheet, (603) 271-3503 or www.state.nh.us

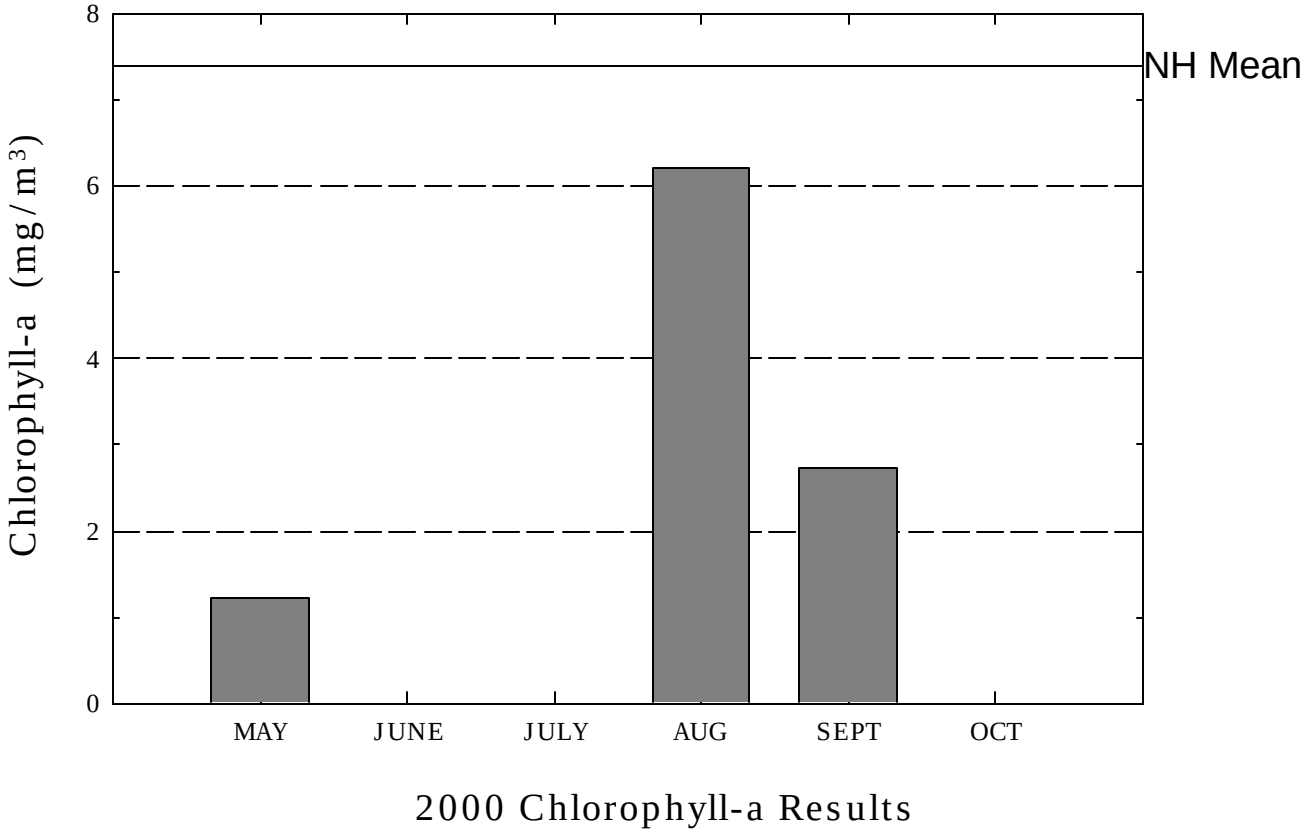
Vegetated Phosphorus Buffer Strips, NH Lakes Association pamphlet, (603) 226-0299 or www.nhlakes.org

Handle With Care: Your Guide to Preventing Water Pollution. Terrene Institute, 1991. (703) 661-1582.

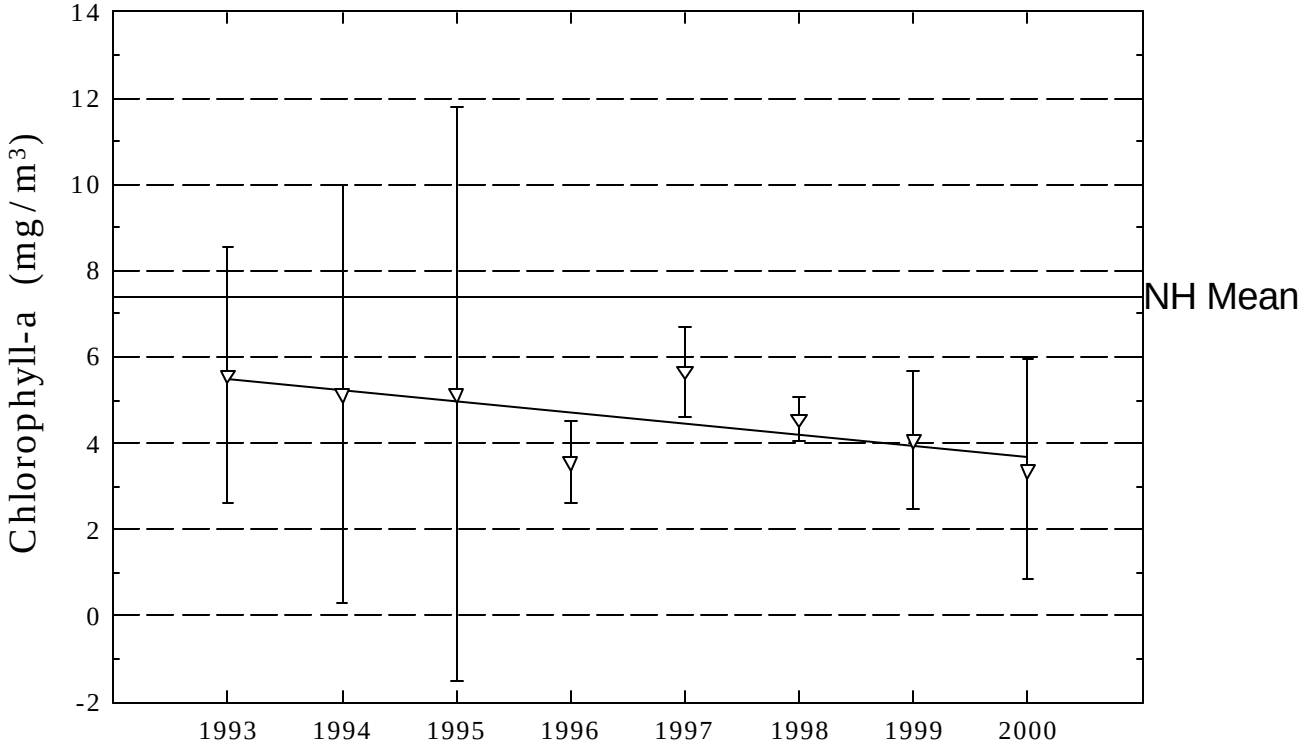
Best Management Practices to Control Nonpoint Source Pollution: A Guide for Citizens and Town Officials, NHDES-WD 97-8, NHDES Booklet, (603) 271-3503

Crystal Lake, Manchester

Figure 1. Monthly and Historical Chlorophyll-a Results



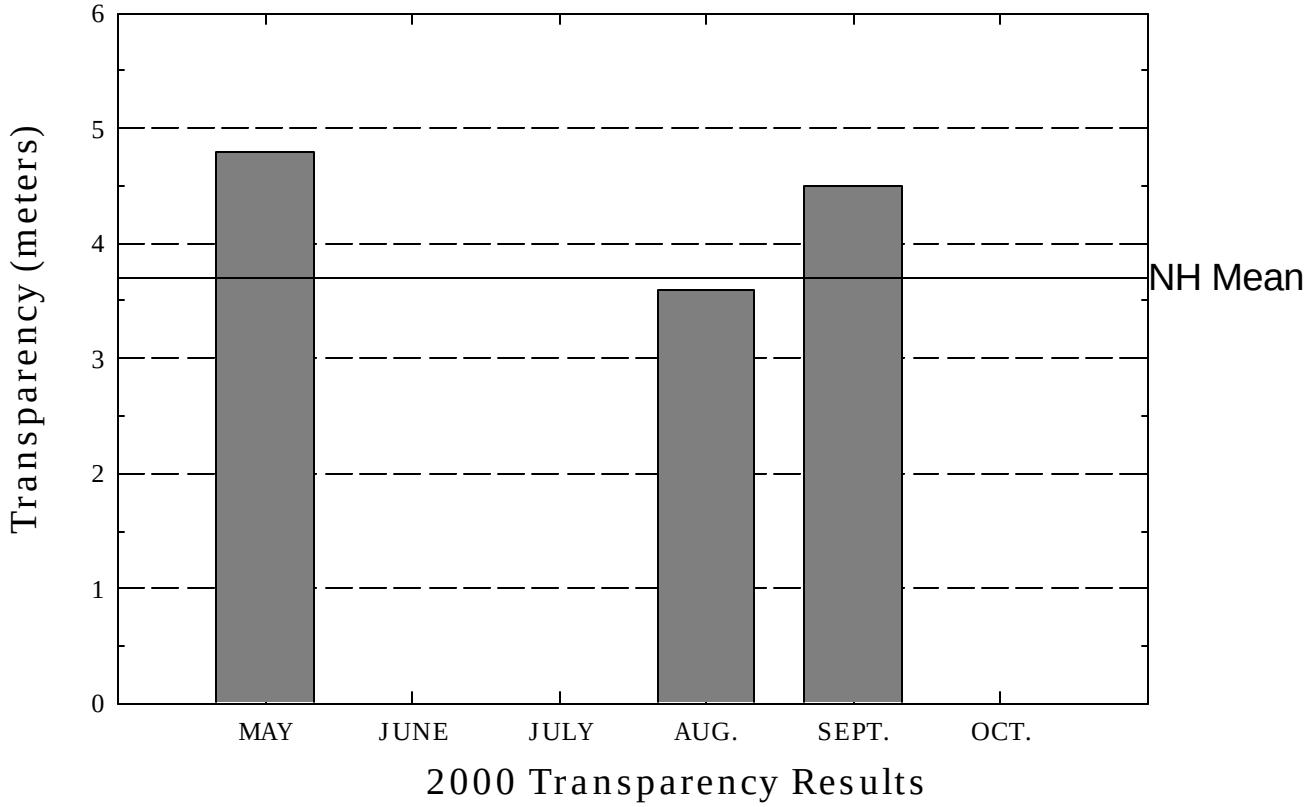
2000 Chlorophyll-a Results

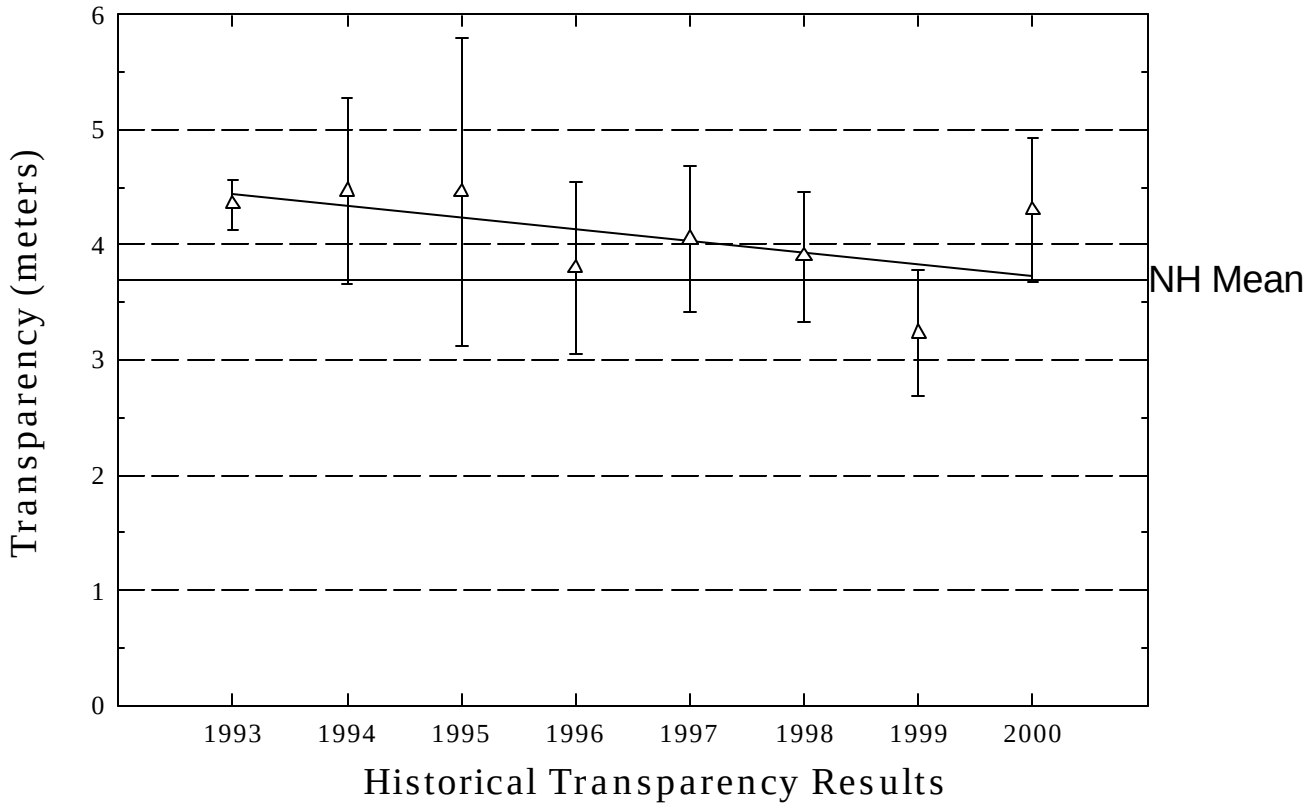


Historical Chlorophyll-a Results

Crystal Lake, Manchester

Figure 2. Monthly and Historical Transparency Results





Crystal Lake, Manchester

Figure 3. Monthly and Historical Total Phosphorus Data.

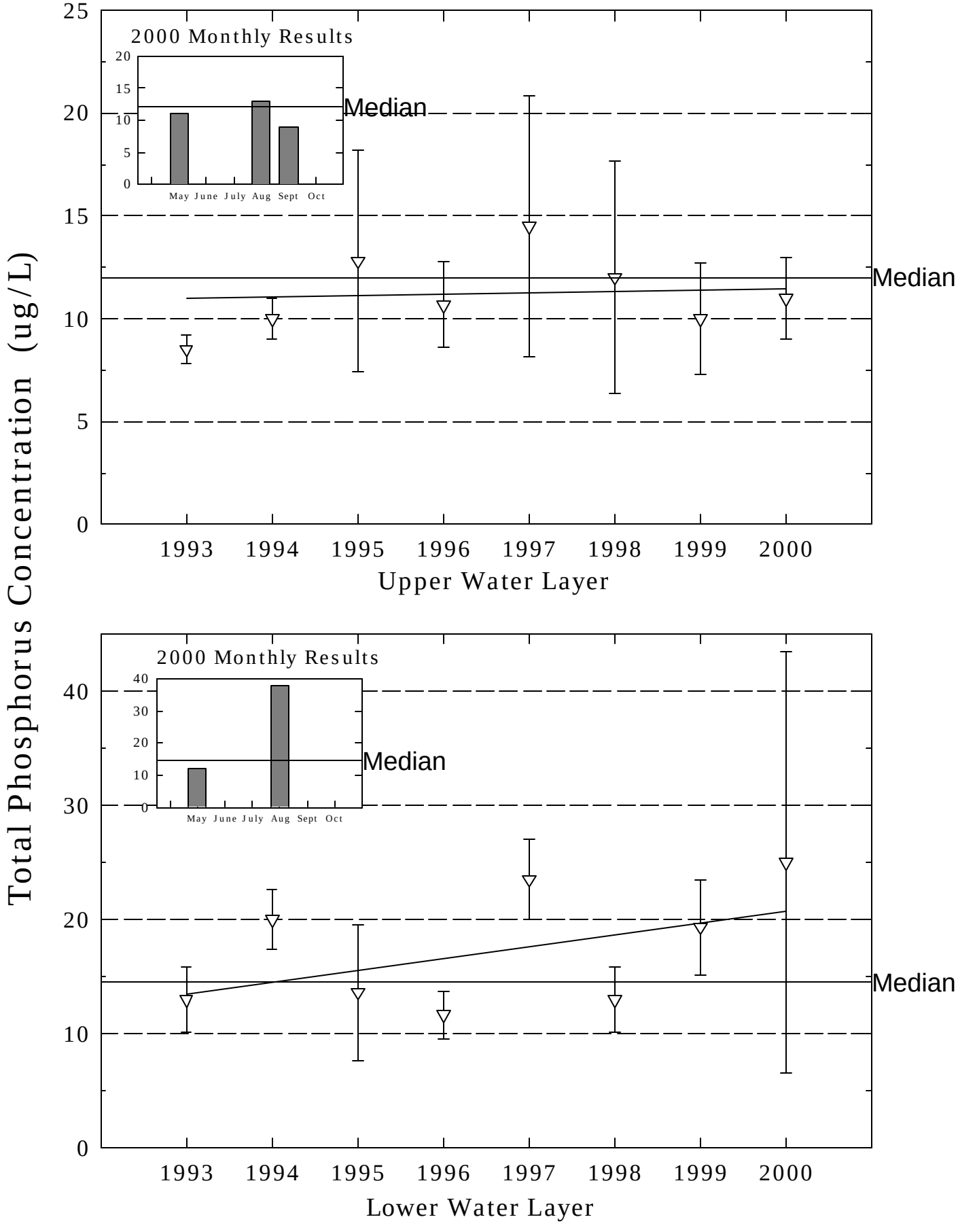


Table 1.

CRYSTAL LAKE

MANCHESTER

Chlorophyll-a results (mg/m^3) for current year and historical sampling periods.

Year	Minimum	Maximum	Mean
1981	6.83	104.04	19.30
1982	3.90	19.20	11.92
1993	3.48	7.68	5.58
1994	1.21	10.57	5.14
1995	0.76	16.81	4.50
1996	2.92	4.65	3.56
1997	4.34	6.40	5.22
1998	4.22	4.93	4.57
1999	1.47	5.48	3.42
2000	1.23	6.21	3.38

Table 2.

CRYSTAL LAKE

MANCHESTER

Phytoplankton species and relative percent abundance.

Summary for current and historical sampling seasons.

Date of Sample	Species Observed	Relative % Abundance
09 / 02 / 1993	COELOSPHAERIUM	31
	MICROCYSTIS	24
	CERATIUM	17
10 / 02 / 1993	DINOBRYON	71
	ASTERIONELLA	23
05 / 07 / 1994	ASTERIONELLA	98
07 / 21 / 1994	DINOBRYON	49
	LYNGBYA	34
08 / 29 / 1994	DINOBRYON	58
	COELOSPHAERIUM	23
	MICROCYSTIS	14
03 / 12 / 1995	ASTERIONELLA	59
	DINOBRYON	25
	PANDORINA	10
05 / 03 / 1995	MELOSIRA	23
	CERATIUM	19
	PANDORINA	13
06 / 14 / 1995	ASTERIONELLA	32
	TABELLARIA	21
	MOUGEOTIA	11
07 / 12 / 1995	MICROCYSTIS	58
	DINOBRYON	14
	CERATIUM	12
08 / 31 / 1995	MICROCYSTIS	30
	FRAGILARIA	26
	DINOBRYON	13
06 / 02 / 1996	ASTERIONELLA	54
	DINOBRYON	37
	MICROCYSTIS	3

Table 2.

CRYSTAL LAKE

MANCHESTER

Phytoplankton species and relative percent abundance.

Summary for current and historical sampling seasons.

Date of Sample	Species Observed	Relative % Abundance
07 / 11 / 1996	DINOBRYON	80
	FRAGILARIA	15
	ASTERIONELLA	3
08 / 29 / 1996	MICROCYSTIS	35
	FRAGILARIA	26
	DINOBRYON	22
06 / 16 / 1997	ASTERIONELLA	44
	ELAKATOTHRIX	17
	ANABAENA	14
06 / 30 / 1997	CERATIUM	70
	MALLOMONAS	13
08 / 28 / 1997	FRAGILARIA	61
	DINOBRYON	30
	MICROCYSTIS	5
06 / 03 / 1998	DINOBRYON	85
	ASTERIONELLA	9
	FRAGILARIA	3
07 / 22 / 1998	FRAGILARIA	53
	MICROCYSTIS	23
	CERATIUM	9
04 / 21 / 1999	DINOBRYON	97
	ASTERIONELLA	3
07 / 21 / 1999	FRAGILARIA	47
	MICROCYSTIS	42
	MALLOMONAS	3
08 / 25 / 1999	COELOSPHAERIUM	40
	MICROCYSTIS	31
	FRAGILARIA	7
05 / 30 / 2000	MALLOMONAS	59
	ASTERIONELLA	35
	CERATIUM	6

Table 2.

CRYSTAL LAKE

MANCHESTER

Phytoplankton species and relative percent abundance.

Summary for current and historical sampling seasons.

Date of Sample	Species Observed	Relative % Abundance
08/24/2000	MICROCYSTIS	28
	FRAGILARIA	24
	COELOSPHAERIUM	18
09/25/2000	COELOSPHAERIUM	39
	DINOBRYON	27
	CERATIUM	

Table 3.

CRYSTAL LAKE

MANCHESTER

Summary of current and historical Secchi Disk transparency results (in meters).

Year	Minimum	Maximum	Mean
1981	1.4	3.5	2.5
1982	3.0	5.0	3.9
1993	4.2	4.5	4.3
1994	4.0	5.4	4.4
1995	2.3	5.8	4.4
1996	3.0	4.5	3.8
1997	3.4	4.5	3.8
1998	3.5	4.3	3.9
1999	2.7	5.3	3.7
2000	3.6	4.8	4.3

Table 4.

CRYSTAL LAKE

MANCHESTER

pH summary for current and historical sampling seasons.
Values in units, listed by station and year.

Station	Year	Minimum	Maximum	Mean
EPILIMNION				
	1981	6.70	7.60	7.13
	1982	7.10	7.30	7.19
	1993	7.20	7.27	7.23
	1994	7.36	7.56	7.47
	1995	6.61	7.55	7.11
	1996	6.46	7.11	6.72
	1997	7.00	7.43	7.13
	1998	6.97	7.36	7.12
	1999	7.03	7.38	7.11
	2000	6.94	7.24	7.08
HYPOLIMNION				
	1981	6.70	7.30	6.90
	1982	7.00	7.10	7.03
	1993	6.66	7.08	6.82
	1994	6.46	7.20	6.64
	1995	6.71	9.00	7.04
	1996	6.62	7.10	6.87
	1997	6.71	7.07	6.85
	1998	6.44	7.10	6.78
	1999	6.72	7.02	6.88
	2000	6.68	7.00	6.81
METALIMNION				
	1999	6.88	7.31	7.06
	2000	6.99	7.16	7.07

Table 4.

CRYSTAL LAKE

MANCHESTER

pH summary for current and historical sampling seasons.
Values in units, listed by station and year.

Station	Year	Minimum	Maximum	Mean
OUTLET				
	1993	7.08	7.08	7.08
	1994	6.94	7.13	7.00
	1995	7.82	7.82	7.82
	1996	7.19	7.19	7.19
	1997	6.88	7.02	6.94
	1998	7.08	7.08	7.08
	2000	7.04	7.04	7.04

Table 5.

CRYSTAL LAKE

MANCHESTER

Summary of current and historical Acid Neutralizing Capacity.
Values expressed in mg/L as CaCO .

Epilimnetic Values

Year	Minimum	Maximum	Mean
1981	19.50	22.00	20.67
1982	7.20	28.00	17.40
1993	21.10	22.00	21.55
1994	15.00	23.00	18.53
1995	15.70	24.20	19.77
1996	2.90	19.30	12.07
1997	15.50	19.90	17.17
1998	15.50	16.50	16.00
1999	16.30	21.90	19.85
2000	16.70	18.90	18.13

Table 5.

CRYSTAL LAKE

MANCHESTER

Summary of current and historical Acid Neutralizing Capacity.
Values expressed in mg/L as CaCO .

Epilimnetic Values

Year	Minimum	Maximum	Mean
1981	19.50	22.00	20.67
1982	7.20	28.00	17.40
1993	21.10	22.00	21.55
1994	15.00	23.00	18.53
1995	15.70	24.20	19.77
1996	2.90	19.30	12.07
1997	15.50	19.90	17.17
1998	15.50	16.50	16.00
1999	16.30	21.90	19.85
2000	16.70	18.90	18.13

Table 6.

CRYSTAL LAKE
MANCHESTER

Specific conductance results from current and historic sampling seasons. Results in uMhos/cm.

Station	Year	Minimum	Maximum	Mean
EPILIMNION				
	1981	306.0	313.0	308.0
	1982	261.0	288.0	272.0
	1993	329.0	330.0	329.5
	1994	312.2	376.0	343.4
	1995	316.0	350.0	334.0
	1996	325.0	354.1	341.0
	1997	340.0	358.0	346.6
	1998	337.0	394.4	365.7
	1999	361.0	400.8	388.1
	2000	416.0	422.0	418.6
HYPOLIMNION				
	1981	302.0	318.0	312.0
	1982	269.0	301.0	283.3
	1993	329.0	332.0	330.5
	1994	323.0	370.0	348.6
	1995	313.0	356.0	336.2
	1996	312.0	348.2	329.4
	1997	324.0	360.0	339.0
	1998	332.0	343.3	336.2
	1999	363.0	400.6	381.2
	2000	405.0	429.0	417.0
METALIMNION				
	1999	356.0	401.8	385.1
	2000	415.0	417.0	416.0

Table 6.

CRYSTAL LAKE
MANCHESTER

Specific conductance results from current and historic sampling seasons. Results in uMhos/cm.

Station	Year	Minimum	Maximum	Mean
OUTLET				
	1993	333.0	333.0	333.0
	1994	304.0	364.0	334.6
	1995	311.0	311.0	311.0
	1996	322.6	322.6	322.6
	1997	341.0	353.0	347.0
	1998	349.8	349.8	349.8
	2000	414.0	414.0	414.0

Table 8.

CRYSTAL LAKE

MANCHESTER

Summary historical and current sampling season Total Phosphorus data. Results in ug/L.

Station	Year	Minimum	Maximum	Mean
EPILIMNION				
	1981	7	29	19
	1982	15	17	16
	1993	8	9	8
	1994	9	11	10
	1995	7	21	12
	1996	9	13	10
	1997	10	19	15
	1998	8	16	12
	1999	6	12	10
	2000	9	13	11
HYPOLIMNION				
	1981	8	38	23
	1982	12	23	17
	1993	11	15	13
	1994	18	23	20
	1995	8	23	13
	1996	10	14	11
	1997	17	26	21
	1998	11	25	16
	1999	16	24	19
	2000	12	38	25
METALIMNION				
	1999	10	18	13
	2000	8	11	9

Table 8.

CRYSTAL LAKE

MANCHESTER

Summary historical and current sampling season Total Phosphorus data. Results in ug/L.

Station	Year	Minimum	Maximum	Mean
OUTLET				
	1993	10	10	10
	1994	8	16	12
	1995	17	17	17
	1996	13	13	13
	1997	10	18	14
	1998	8	8	8
	2000	11	11	11

Table 9.

CRYSTAL LAKE

MANCHESTER

Current year dissolved oxygen and temperature data.

Depth (meters)	Temperature (celsius)	Dissolved Oxygen (mg/L)	Saturation (%)
		August 24, 2000	
0.1	24.6	8.6	103.0
0.5	24.3	8.7	104.0
1.0	22.7	8.7	100.0
2.0	22.2	8.7	100.0
3.0	22.0	8.3	95.0
4.0	21.8	7.7	88.0
5.0	21.1	2.9	33.0
6.0	17.0	0.2	2.0
		September 25, 2000	
0.1	19.8	7.3	79.5
1.0	19.7	7.3	79.5
2.0	19.2	7.1	76.9
3.0	19.0	7.0	75.2
4.0	19.0	7.0	74.9
5.0	18.8	6.8	72.9
6.0	18.7	6.5	70.0

Table 10.

CRYSTAL LAKE

MANCHESTER

Historic Hypolimnetic dissolved oxygen and temperature data.

Date	Depth (meters)	Temperature (celsius)	Dissolved Oxygen (mg/L)	Saturation (%)
September 2, 1993	6.0	17.1	0.3	3.0
October 2, 1993	6.5	14.5	0.6	6.0
July 22, 1994	6.0	16.5	0.6	6.0
July 28, 1994	15.0	10.0	0.6	5.0
August 29, 1994	5.8	20.3	0.2	3.0
May 3, 1995	5.0	9.8	16.0	138.0
May 3, 1995	6.0	9.0	15.0	130.0
June 14, 1995	6.0	13.5	11.7	109.0
July 12, 1995	6.0	15.2	0.0	0.0
August 31, 1995	5.5	21.5	3.2	36.0
June 2, 1996	6.0	12.0	7.0	65.0
July 11, 1996	5.5	15.7	1.7	17.0
August 29, 1996	6.0	18.5	0.9	9.0
June 16, 1997	6.0	10.8	4.2	37.0
June 30, 1997	6.0	12.2	8.6	79.0
August 28, 1997	6.0	16.7	0.5	5.0
June 3, 1998	6.0	14.1	8.5	82.0
July 22, 1998	6.0	14.8	0.1	1.0
July 21, 1999	6.0	15.2	0.4	4.2
August 24, 2000	6.0	17.0	0.2	2.0
September 25, 2000	6.0	18.7	6.5	70.0

Table 11.

CRYSTAL LAKE
MANCHESTER

Summary of current year and historic turbidity sampling.
Results in NTU's.

Station	Year	Minimum	Maximum	Mean
EPILIMNION				
	1997	0.5	0.7	0.6
	1998	0.4	0.7	0.5
	1999	0.5	2.6	1.1
	2000	0.4	0.5	0.4
HYPOLIMNION				
	1997	1.0	3.0	2.0
	1998	0.7	1.5	0.8
	1999	0.6	1.7	1.3
	2000	0.6	5.5	3.0
METALIMNION				
	1999	0.4	1.7	0.9
	2000	0.4	0.5	0.5
OUTLET				
	1997	0.5	0.7	0.6
	1998	0.6	0.6	0.6
	2000	0.4	0.4	0.4

Table 12.

CRYSTAL LAKE

MANCHESTER

Summary of current year bacteria sampling.
Results in counts per 100ml.

Location	Date	E. Coli See Note Below
CARDINS		
	May 30	2
	August 24	3
	September 25	2
CORNING RD DRAIN		
	May 30	0
HORSE AREA		
	May 30	45
	August 24	2
	September 25	3
NEAR ST OUTLET		
	August 24	< 1
	August 24	1
OUTLET		
	May 30	35
PUBLIC BEACH		
	May 30	0
	August 24	1
	September 25	5

NOTE: "<" means "less than" and ">" means "greater than"